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(54) Pressure regulating device

(57) A pressure regulating device 1 comprises a housing having inlet ducts 7, 8 and defining therein mutually opposed chambers 3, 4 which are sealed from one another by means of a flexible diaphragm 5. The diaphragm 5 is coupled to respective regulating valves 9, 10 arranged upstream of the chambers 3, 4 in such a way that increase in fluid pressure in chamber 3 displaces the diaphragm to reduce the flow rate into that chamber and that for an operational range of inlet pressures an equilibrium condition of the diaphragm 5 and valves 9, 10 is maintained wherein the ratio between the fluid pressures in the respective chambers 3, 4 and accordingly at respective outlet ducts 11 of the device 1 remains substantially constant. In other embodiments two axially-spaced diaphragms 5 are rigidly connected by a push-rod (20, Figs. 3, 5) and positively secured to valves 9,10.

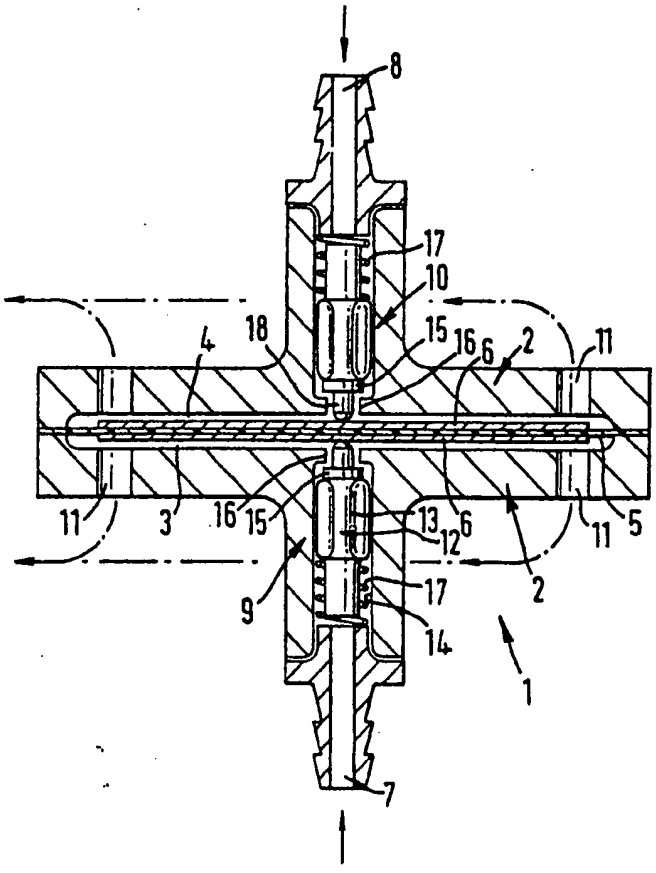

FIG.1

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

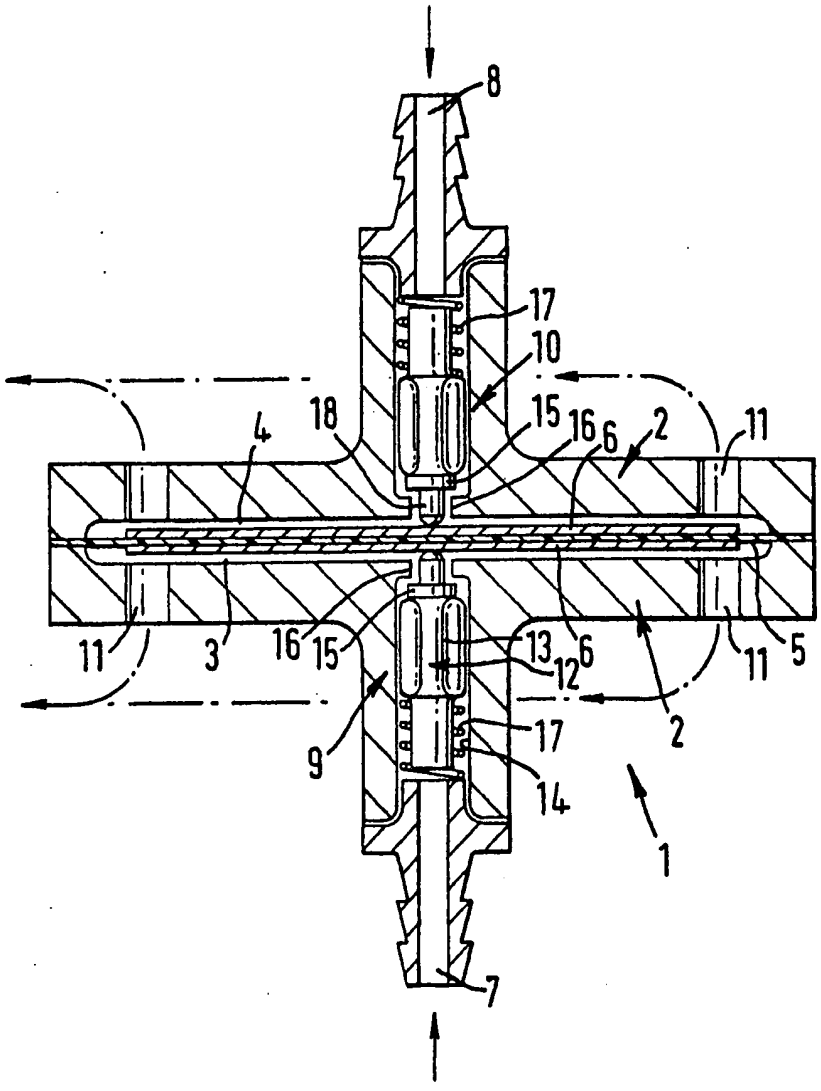

FIG.1

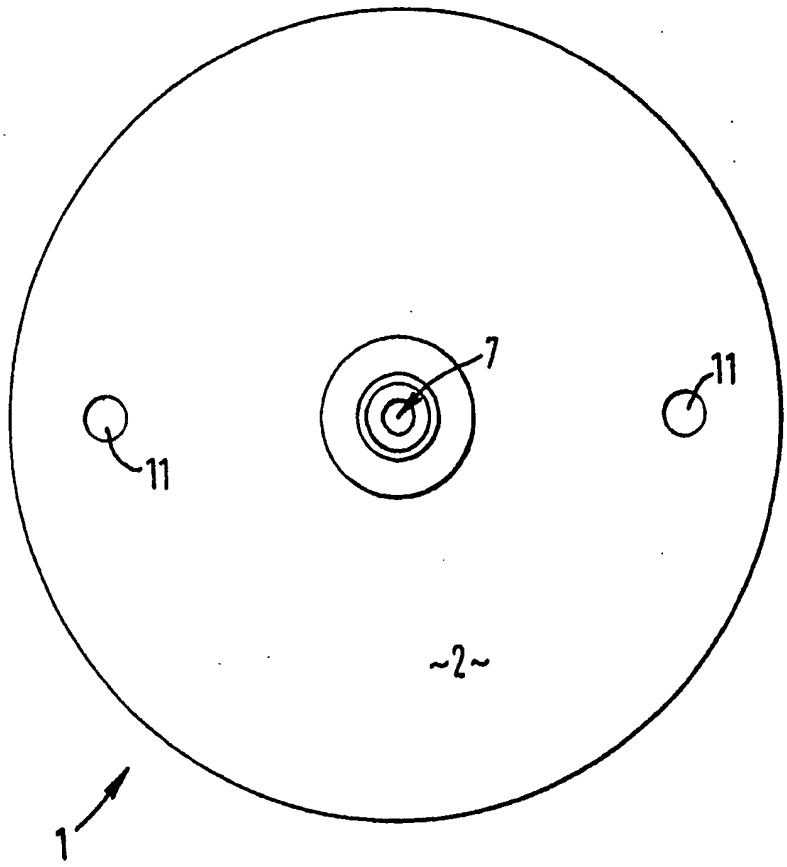

FIG.2

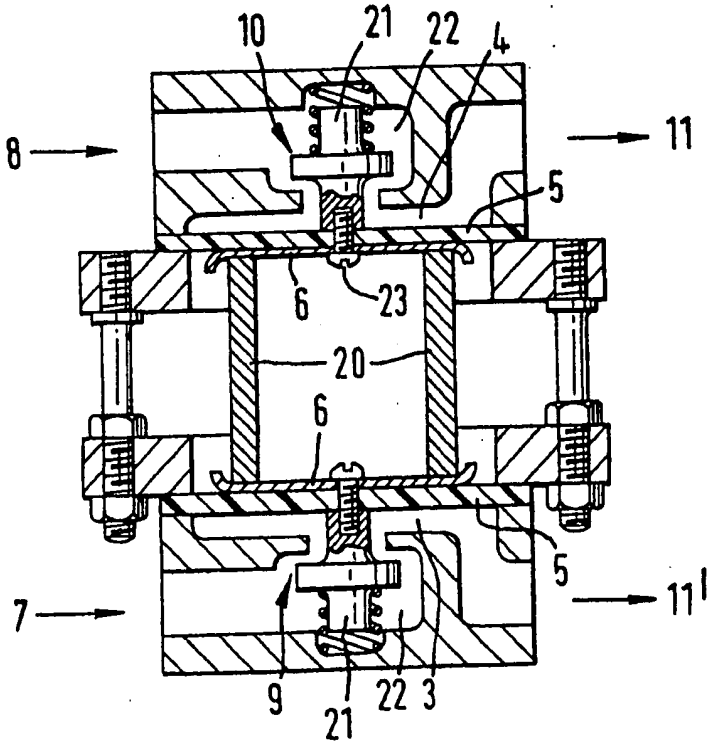

FIG. 3

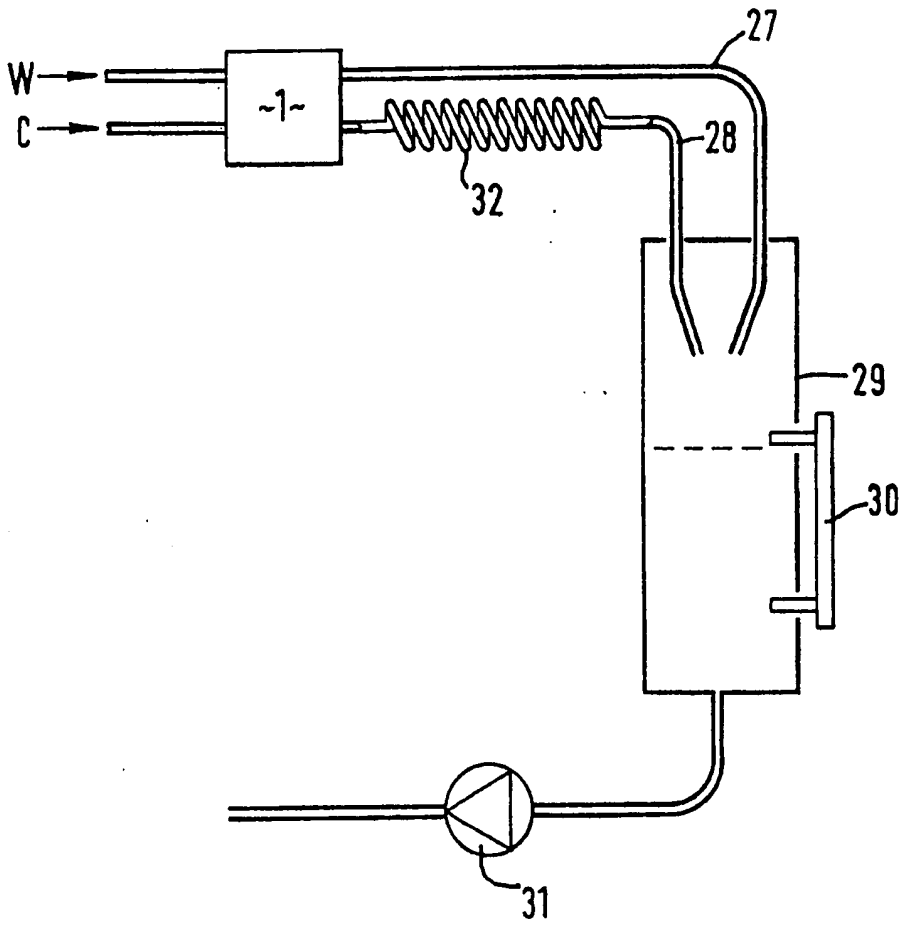

FIG. 4

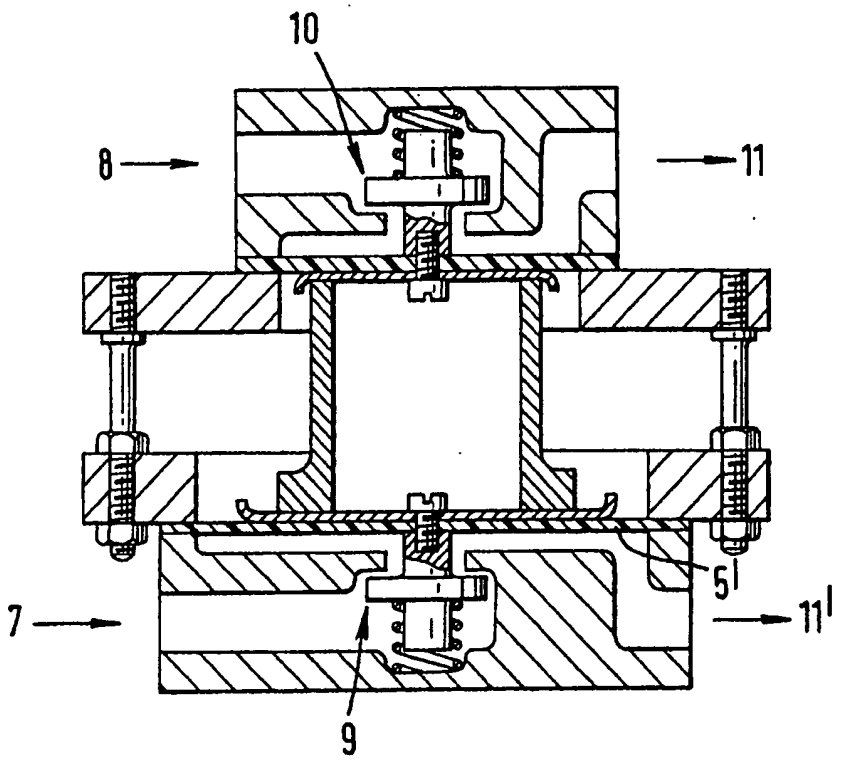

FIG. 5

SPECIFICATION

Pressure regulating device

This invention relates to a pressure regulating device, and is particularly, but not exclusively concerned with a device which is adapted to maintain substantially equal fluid pressures in a pair of flow lines arranged in parallel.

In many instances it may be desired to provide flow lines which supply fluid at equal pressures. For example, in a system which requires that two fluids be mixed together in a precise, predetermined ratio, in the event that the fluids are supplied at constant relative pressures, the correct ratio of the mixture may be selected by providing a suitable resistance or constriction in one of the lines. However, such an arrangement is sensitive to fluctuations in the source pressure of either fluid, since mixing in the required ratio will not of course occur unless the ratio of the fluid pressures is constant.

An example of a system where mixing of two fluids in a precise ratio is required and where the above problem can occur is an apparatus for blending concentrate and e.g. water in a beverage dispensing system. In such a system the constituents are generally supplied from pressurised bottles casks or supply pumps, and a suitable restriction is placed in the concentrate supply line whereby to achieve a required concentration of the beverage. In a known such arrangement each supply line has been provided with a simple throttle device whereby the pressures may be set initially. However, clearly this arrangement is vulnerable to changes in pressure of the supply bottles or supply pumps. Whilst the resulting fluctuations in the proportions of the constituents in the beverage may in the case of soft drinks be acceptable to the consumer, where it is desired to employ a reconstitution technique with e.g. alcoholic beverages it is essential that concentrate and water are mixed in precise proportions in order that the final beverage has a correct alcoholic strength. Thus, although there are clear advantages as regards transportation and storage in supplying for example beer in a concentrated form for subsequent mixing with carbonated water, problems have been encountered in providing a sufficiently accurate and reliable mixing system suitable for installation e.g. in public houses and hotels.

According to the invention there is provided a pressure regulating device comprising a housing having formed therein mutually opposed first and second chambers which communicate with respective fluid inlet and outlet ducts of the device and which are sealed from one another by means of a flexible diaphragm, such diaphragm being coupled to respective regulating valves arranged upstream of the respective chambers in such a way that in use of the device displacements of the diaphragm in response to any increases in fluid pressure in the first chamber relative to the fluid pressure in the second chamber are effective to reduce the flow rate into the first chamber relative to that into the second, whilst displacements of the diaphragm in the opposite sense have the reverse effect, whereby at least over a certain range of inlet pressures an equilibrium condition of the diaphragm and valves is maintained wherein the ratio between the fluid pressures in the respective chambers and accordingly at the respective outlet ducts remains substantially constant.

Thus, in the use of the device the inlet ducts are connected to respective fluid sources. The fluid entering the device via each inlet duct flows past the respective regulating valve into the first or second chamber and thereafter leaves the device via the respective outlet duct. The coupling of the valves to the flexible diaphragm which separates the first and second chambers is such that the ratio between the fluid pressures in the chambers and thus at the respective outlet ducts remains substantially constant, at least over an operational range of inlet pressures, regardless of differences between or fluctuations in the fluid pressures at the respective inlet ducts. For example, assuming that the fluid pressure in the supply line connected to the first chamber increases, the resulting pressure differential across the diaphragm will displace the diaphragm in such a way to cause the regulating valves to reduce the flow into the first chamber relative to that into the second chamber. In this way, the equilibrium condition will be restored. In the event that the pressure in the supply line leading to the first chamber then falls, the diaphragm will be displaced in the opposite sense thus increasing the flow into the first chamber relative to that into the second and again restoring the equilibrium.

In a particularly advantageous embodiment the surface area presented by the diaphragm is equal for the two chambers, and in this case the equalibrium condition is therefore created when the fluid pressures in the first and second chambers are equal. Thus, the apparatus may serve as a device for equalising the fluid pressure in parallel fluid lines.

Such a device may be used in any system where a supply of fluids at equal pressures is desired. The device is applicable either to liquids or to gaseous fluids.

Clearly, such a device is particularly applicable to apparatus for blending the constituents of a beverage where precise proportions for example of beverage concentrate and aerated water are required. The inlets of the device may be connected to the sources of the respective constituents, and the respective outlets connected either to a suitable mixing

chamber or directly to a dispensing tap via respective lines providing suitable flow resistances to achieve the required ratio.

The use of a diaphragm to separate the first and second chambers is advantageous in that such prevents any leakage between the two chambers and at the same time is freely displaceable in response to pressure differences between the chambers with the minimum of friction to provide good sensitivity to relative changes in inlet pressure. Thus, a diaphragm of suitable resilience will be displaced by and thus be sensitive to very small pressure fluctuations.

Thin reinforcing plates are preferably carried by the diaphragm in order to prevent buckling or bowing thereof in use which could result in inconsistent operation of the device. Furthermore, two or more outlet ducts may be provided leading from each chamber which are arranged symetrically with respect to the diaphragm, since in this way the possibility of pressure irregularities across the surface of the diaphragm which again could impair consistent operation is minimised. Moveover, the provision of two or more outlet ducts from each chamber assists in promoting self cleaning of the internal parts of the housing.

The regulating valves of the device in accordance with the invention may take any convenient form, although in a particularly preferred embodiment each valve includes a closure member which is arranged so as to be urged towards a respective valve seat under the effect of the fluid flowing into the respective chamber, but which is coupled to the diaphragm so as to be normally held in a spaced condition from such seat. The closure members and seats are preferably axially arranged relative to the housing in mutually opposed relation, each closure member including a protruding part which extends through the respective seat and engages a respective plate carried by the diaphragm. In this way the closure members of the regulating valves are coupled directly to the diaphragm, and displacements of the diaphragm in response to a pressure increase for example in the first chamber will cause the valve associated with that chamber to close slightly and the valve associated with the other chamber to open by a corresponding amount until the equilibrium condition is restored. It will therefore be seen that with this arrangement the equilibrium condition is restored both by the fluid flow rate into one chamber being increased and by that into the other chamber being reduced. It is envisaged that the valve closure members may be secured to and effectively carried by plates secured to the diaphragm, or alternatively the closure members may simply be biased into engagement with such plates, e.g. by light compression springs. In either case, the arrangement of the closure members and seats of the valves is preferably such that only very slight displacements of the diaphragm are effective to change the flow rates through the respective valves sufficiently to maintain equal pressures in the chambers.

In one embodiment two diaphragms are provided which are axially spaced within the housing and which and are interconnected e.g. by a push rod or the like. In an alternative embodiment, the housing is of reduced axial extent, and a single diaphragm separates the first and second chambers.

The operational range of inlet pressures over which a device in accordance with the invention will maintain pressures at substantially constant ratios at its outlet ducts will be largely dependent on the dimensions of the chambers, and the characteristics of the valves, but in general terms there must be sufficient pressure at each inlet duct to keep the device flooded throughout. It should also be appreciated that whilst the preferred device in accordance with the invention may produce substantially equal outlet pressures for a range of different inlet pressures, the absolute value of the outlet pressure will change. However, in for example an apparatus for mixing fluids in a constant ratio, variations in the absolute pressure do not affect the proportions of the constituents so long as the ratio in pressures remains constant.

The invention has been mainly discussed above in terms of a device for equalising fluid pressures. However, it should be appreciated that the device could be modified whereby to provide fluid pressures at its outlet ducts which although being at a constant ratio were unequal. In such a modification the surface area presented by the diaphragm is different for the two chambers such that the equalibrium condition is one wherein the pressures in the chambers are unequal, since the force exerted on the diaphragm from the fluid in each chamber is dependent both on the pressure in the chamber and on the surface area of the wall member acted on by the fluid.

The invention extends to apparatus for mixing constituents of a beverage incorporating a pressure regulating device of the type set out above. As discussed above, in such apparatus the proportions of the constituents may be set by providing a suitable constriction or resistance in one of the outlet lines, usually that supplying the concentrate of the beverage. Alternatively, so-called tuned pipes of different diameters may be used. In one embodiment the fluids from the outlet pipes are introduced into a mixing chamber, from which the final beverage may be dispensed. Alternatively, the outlet lines may be directly connected to for example a dispensing tap. Furthermore, the lines may be joined by means of a Y section or T section tube wherein mixing of the fluid occurs.

Certain embodiments of the invention will now be described, by way of example only,

with reference to the accompanying drawings, wherein;

Figure 1 is a view in cross-section of a pressure regulating device in accordance with the invention;

Figure 2 is an end view of the device illustrated in Figure 1;

Figure 3 is a view in cross-section of an alternative embodiment of pressure regulating device;

Figure 4 illustrates schematically the application of the pressure regulating device to an apparatus for mixing beverages; and

Figure 5 illustrates a still further embodiment.

Referring to Figures 1 and 2, a pressure regulating device 1 comprises a housing formed from two like side portions 2 which are interconnected adjacent their outer periphery e.g. by screws (not shown). Defined within the housing are first and second opposed chambers 3,4 which are separated by means of a flexible diaphragm 5 which extends across the interior of the housing and which is sealingly engaged at its outer periphery between the side portions 2 of the housing. Thin reinforcing plates 6 are secured to the diaphragm 5 on either side thereof.

The device further includes axially arranged inlet ducts 7,8 which communicate with the respective chambers 3,4 via axially directed regulating valves 9,10. Each chamber 3,4 is provided with two outlet ducts 11, which are diametrically opposed as shown in Figure 2 Each regulating valve 9,10 comprises an axially slidable body portion 12 provided with flutes 13 whereby the portion 12 is precisely located within a respective axial bore 14 but at the same time fluid can flow thereby towards the respective chamber 3,4. Each valve includes a closure member 15 carried by the portion 12 and moveable relative to a respective valve seat 16 formed at the end of the bore 14. A biasing spring 17 urges each valve body portion 12 inwardly towards the respective seat 16, the valves normally being held in an open condition by engagement of protruding parts 18, which extend through the seats 16, with the plates 6 carried by the diaphragm 5.

In use of the device, the inlet ducts 7,8 are connected to respective fluid sources, and as illustrated by the arrows in Figure 1 fluid flows through each side of the device via the regulating valves 9,10 through the respective chambers 3,4 and out via the outlet ducts 11. The coupling of the displaceable wall member in the form of diaphragm 5 and plates 6 to the regulating valves 9,10 is such that the fluid pressures in the chambers 3,4 and thus at the outlet ducts remain substantially equal over an operational range of inlet pressures, regardless of differences in inlet pressure at the ducts 7,8. Assuming that for example the inlet pressure at the duct 7 is greater than that at the duct 8, the pressure differential between the chamber 3 and the chamber 4 will cause the diaphragm and plates to be displaced upwardly as shown in Figure 1. This causes the valve 9 to close slightly and the valve 10 to open by a corresponding amount whereby the fluid pressure in the chamber 4 is increased relative to that in the chamber 3 until the pressures in the chambers and thus at the outlet ducts are substantially equal. Conversely, in the event that the inlet pressure at the duct 7 falls below that at the duct 8, a reverse displacement occurs such that opening of the valve 9 and closing of the value 10 occurs until the fluid pressures in the chambers 3,4 are again equal.

For successful operation of the pressure regulating device, there must be sufficient fluid pressure at both inlets to keep the device flooded with fluid throughout. A device of the sort illustrated in Figure 1 has been found to produce substantially constant outlet pressures over a range of inlet pressures at the ducts 7 and 8 of approximately 20 to 60 pounds per square inch. It will be appreciated that in response to changes in the inlet pressures the absolute value of the outlet pressure will vary, but that in a system for mixing fluids in a predetermined ratio variations in the absolute pressure do not affect the proportions of the constituents so long as the outlet pressures remain equal.

Turning now to Figure 3 an alternative embodiment of pressure regulating device is illustrated. In this embodiment the chambers 3,4 are axially spaced from one another, and are separated and sealed by two spaced diaphragms 5. The diaphragms each carry a plate 6 the plates being interconnected by a cylindrical push rod 20. In this embodiment the inlet ducts 7,8 and outlets ducts 11, are radially directed, and the displaceable portions 21 of the regulating values 9,10 are mounted in cylindrical cavities 22. Furthermore, in this embodiment the moveable valve portions 21 are carried by the diaphragms 5 and plates 6 and are secured thereto by means of screws 23. It will be seen that the device illustrated in Figure 3 operates in exactly the same way as that illustrated in Figure 1, displacements of the diaphragms 5 and plates 6 in response to pressure differences between the chambers 3 and 4 causing the valves 9 and 10 to adjust to an equilibrium condition wherein the outlet pressures are equal.

Referring to Figure 4 there is shown schematically an apparatus for mixing the constituents of a beverage which incorporates a pressure regulating device 1. The inlets of the device 1 are connected to pressurised supplies of beverage concentrate and aerated water respectively. The outlets of the device are connected via lines 27,28 to a mixing chamber 29 which is provided with an automatic level controller 30. A pump 31 is effective to

draw the mixed beverage from the chamber 29 to be dispensed e.g. from taps (not shown). Line 28 through which the concentrate is supplied to the chamber 29 is provided with a fluid resistance 32 adapted to provided the required ratio of concentrate to water, for example 1—4. Since the pressures of concentrate and water will be equalised by the device 1, the system will be immune to fluctuations in the source pressure of either the concentrate or water. In an alternative arrangement, it is envisaged that the mixing chamber 29 will be omitted and the lines 27 and 28 will instead be joined by a Y section tube in which mixing will occur. In this way, the fluid from the lines 27,28 may be applied directly to beverage dispensing taps in for example a hotel or public house. In a further modification, the fluid resistance 32 may be omitted and instead so-called tuned pipes provided which are of appropriate relative diameters whereby the correct proportions of the constituents are achieved.

Referring lastly to Figure 5, there is illustrated an embodiment similar to that shown in Figure 3 wherein one diaphragm 5' is larger than the other. In this embodiment the pressures at the outlet, whilst being at a constant ratio for a range of inlet pressures, are unequal. Thus, the equalibrium condition will be one wherein the pressure in the upper chamber (adjacent the smaller diaphragm) is greater than that in the lower chamber.

CLAIMS

1. A pressure regulating device comprising a housing having formed therein mutually opposed first and second chambers which communicate with respective fluid inlet and outlet ducts of the device and which are sealed from one another by means of a flexible diaphragm, such diaphragm being coupled to respective regulating valves arranged upstream of the respective chambers in such a way that in use of the device displacements of the diaphragm in response to any increases in fluid pressure in the first chamber relative to the fluid pressure in the second chamber are effective to reduce the flow rate into the first chamber relative to that into the second, whilst displacements of the diaphragm in the opposite sense have the reverse effect, whereby at least over a certain range of inlet pressures an equalibrium condition of the diaphragm and valves is maintained wherein the ratio between the fluid pressures in the respective chambers and accordingly at the respective outlet ducts remains substantially constant.

2. A device as claimed in claim 1 wherein the diaphragm carries one or more reinforcing plates.

3. A device as claimed in claim 1 or 2 wherein each chamber is provided with two or more outlet ducts arranged symetrically with respect to the diaphragm.

4. A device as claimed in any preceding claim wherein each valve includes a closure member arranged so as to be urged towards a respective valve seat under the effect of fluid flowing into the respective chamber, each closure member being coupled to the diaphragm so as to be normally held in a spaced condition from its respective seat.

5. A device as claimed in claims 2 and 4 wherein the respective closure members and seats are axially arranged relative to the housing in mutually opposed relation, each closure member including a protruding part which extends through the respective seat and engages a respective plate carried by the diaphragm.

6. A device as claimed in any preceding claim comprising two diaphragms axially spaced within the housing and interconnected by means of a push rod or the like, each diaphragm being associated with a respective regulating valve.

7. A device as claimed in any preceding claim adapted to maintain substantially equal fluid pressures in the respective chambers.

8. A device as claimed in any of claims 1 to 6 adapted to maintain unequal pressures in the respective chambers at a substantially constant ratio.

9. A pressure regulating device substantially as herein described with reference to Figures 1 and 2 of the accompanying drawings.

10. A pressure regulating device substantially as herein described with reference to Figure 3 of the accompanying drawings.

11. A pressure regulating device substantially as herein described with reference to Figure 5 of the accompanying drawings.

12. Apparatus for mixing the constituents of a beverage including a pressure regulating device as claimed in any preceding claim.

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